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CODED-WIRE TAG RECOVERIES FROM PINK SALMON IN PRINCE WILLIAM SOUND FISHERIES, 1995

by

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Exxon Valdez Oil Spill
Restoration Project Annual Report

Coded Wire Tag Recoveries from Pink Salmon in Prince William Sound Salmon Fisheries, 1995

Restoration Project 95320B
Annual Report

This annual report has been prepared for peer review as part of the *Exxon Valdez* Oil Spill Trustee Council restoration program for the purpose of assessing project progress. Peer review comments have not been addressed in this annual report.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

Coded Wire Tag Recoveries from Pink Salmon in Prince William Sound Salmon Fisheries, 1995

Restoration Project 95320B
Annual Report

Study History:

The pink salmon coded wire tag program in Prince William Sound was initiated in 1986 to partition returns of pink salmon into wild and hatchery stocks, and to determine the size of the hatchery return. After the *Exxon Valdez* oil spill, the program was incorporated into Natural Resource Damage Assessment Fish/Shellfish Study 3, to document effects of the spill on wild pink salmon by comparing returns to oiled and unoiled streams, as well as to estimate the size of hatchery and wild stock returns. The project continued under Restoration Study 60A (Coded wire tag studies on Prince William Sound pink salmon), Restoration Study 93067 (Coded wire tag recoveries from pink salmon in Prince William Sound salmon fisheries, 1993), and Restoration Study 94320B (Coded wire tag recoveries from pink salmon in Prince William Sound salmon fisheries, 1994).

Abstract:

During 1994, about a half billion pink salmon fry were released into Prince William Sound from the A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch hatcheries. About one million of these were tagged with half-length coded wire tags. During 1995, tags from these releases were recovered in the commercial catch. Estimates of hatchery contributions based upon detected tags, a historical W.H. Noerenberg adjustment factor (1989-1994) to account for tag loss and differential mortality, and an overall expansion factor were given to management biologists. Some of these estimates did not agree with postseason estimates because of the extraordinary survival of experimental releases which were tagged at a higher rate. Postseason analysis using tag-specific expansion factors and an updated historical W.H. Noerenberg adjustment factor (1989-1995) revealed that of the 17.16 million pink salmon caught commercially in 1995, the A.F. Koernig W.H. Noerenberg Cannery Creek and Solomon Gulch hatcheries contributed 0.78 million, 2.37 million, 3.17 million, and 6.76 million pink salmon, respectively. The wild contribution was 4.08 million fish. The 1995 Cannery Creek hatchery contribution may have been underestimated as a result of tag shedding problems. The overall survival rates for pink salmon from A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch hatcheries were 0.83%, 1.42%, 3.75% and 4.52%, respectively.

Key Words:

Coded wire tag, commercial harvest, hatchery, *Oncorhynchus gorbuscha*, pink salmon, Prince William Sound, wild stock.

Citation:

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EXECUTIVE SUMMARY

This report documents Restoration Study 95320B, one of the projects designed to restore the pink salmon *Oncorhynchus gorbuscha* resource of Prince William Sound to its pre-spill status. Coded wire tags applied in 1994 at four hatcheries in Prince William Sound, the W.H. Noerenberg, Cannery Creek, A. F. Koernig and Solomon Gulch facilities, were recovered in the commercial catch of 1995 and used to provide inseason and postseason estimates of hatchery contributions. Inseason estimates were used by fishery managers to target the numerically superior hatchery returns, and thus to reduce the pressure placed upon oil-damaged wild stocks. Inseason estimates were made in two stages. Preliminary estimates were based solely on detected tags (not extracted) and were made available to managers upon completion of sampling. These estimates were then updated approximately three days later with code-specific information.

The postseason analysis revealed that out of a commercial catch of 17.16 million pink salmon, 4.08 million fish were estimated to be of wild origin. Of the hatchery component (estimated at 13.08 million pink salmon), 0.78 million, 2.37 million, 3.17 million, and 6.76 million originated from the A.F. Koernig, W.H. Noerenberg, Cannery Creek and the Solomon Gulch hatcheries, respectively. Overall adult survival rates of hatchery reared pink salmon were 0.83%, 1.42%, 3.75%, and 4.52%, for the A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch facilities, respectively.

INTRODUCTION

Between 1961 and 1976, when hatcheries were absent from Prince William Sound, the commercial seine harvest of wild pink salmon *Oncorhynchus gorbuscha* averaged about 3.4 million fish. In the early 1970's, run failures led to an aggressive enhancement program which included construction of hatcheries. By 1986 five hatcheries were operating in Prince William Sound (Figure 1): the Solomon Gulch hatchery, producing pink salmon, and later, chum *O. keta*, and coho salmon *O. kisutch*, the A. F. Koernig hatchery, producing pink salmon, the W.H. Noerenberg hatchery, producing pink salmon, and later, chum, coho and chinook salmon *O. tschawytscha*, the Cannery Creek hatchery, producing pink salmon, and the Main Bay hatchery which produced chum and presently raises sockeye salmon *O. nerka*.

To protect wild stocks in a hatchery-dominated fishery, managers needed information pertaining to the temporal and spatial distributions of hatchery and wild fish. To meet this requirement, a coded wire tagging program was initiated in 1986 for hatchery releases of pink salmon with recovery of tagged returning adults in commercial and cost-recovery fisheries beginning in 1987. Tag recovery data enabled managers to estimate hatchery and wild contributions to catches from temporal and spatial strata within the fishery.

The March 24, 1989, *Exxon Valdez* oil spill exacerbated the problems faced by the fishery manager. The spill contaminated intertidal portions of streams where the majority of wild salmon stocks in western Prince William Sound spawn as well as the marine waters traversed by juvenile salmon on their migration seaward through the Sound. The decisions made by fishery managers suddenly became more complicated in so far as they affected wild populations injured by the oil spill. The coded wire tagging program was expanded under the Natural Resource Damage Assessment Fish/Shellfish # 3 study (Sharr et al, 1995a), and Restoration Studies 60A, 93067 and 94320B (Sharr et al, 1995b,c and e) to include tagging of wild fish, which allowed comparison of the survival rates of wild salmon in oiled versus unoiled streams. In recent years, the emphasis of the program has been to provide management biologists with timely data on the relative abundances of wild and hatchery stocks, and has allowed direction of fishing effort towards the hatchery returns. For 1995, the program was supported by Restoration study 95320B, along with matching funds from the Prince William Sound Aquaculture Corporation, the Valdez Fisheries Development Association, and the Alaska Department of Fish and Game.

This report documents the activities and results of the coded wire tag program for the 1995 recovery year. It focuses primarily upon hatchery contributions to the different fisheries, survival rates of different hatchery release groups, and inseason estimation of contributions. Unaggregated data is presented in appendices .

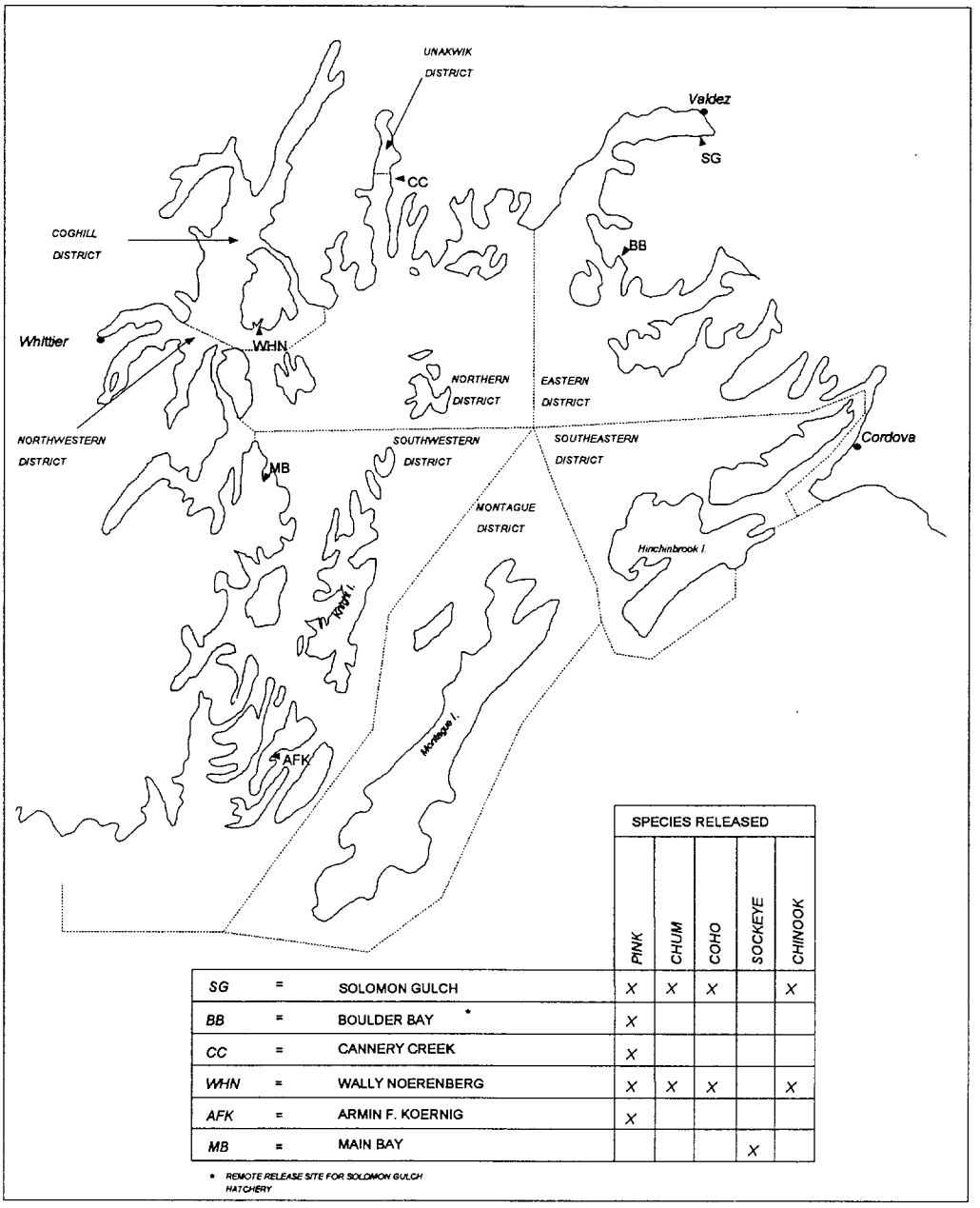

Figure 1 Fishing districts and hatcheries of Prince William Sound, Alaska

OBJECTIVES

1. To make determinations of wild and hatchery components of the pink salmon commercial fisheries of 1995 and to make these available to fishery managers on an inseason basis, so that fishing effort may be directed towards hatchery stocks.

2. To estimate marine survival rates for each uniquely coded hatchery release group returning in 1995.

3. To evaluate the method selected in 1993 for inseason analysis of coded wire tag data, whereby an historical adjustment factor and numbers of detected (undecoded) tags are used to estimate the hatchery and wild contributions.

METHODS

Tagging

Tagging of pink salmon fry occurred at the three Prince William Sound Aquaculture Corporation facilities (W.H. Noerenberg, Cannery Creek, and A. F. Koernig hatcheries) and at the Valdez Fisheries Development Association facility (Solomon Gulch hatchery). Tagging rates and recovery efforts should yield contribution estimates which are sufficiently precise to allow fishery managers to make meaningful inseason decisions. Assuming a potential sampling rate of approximately 20% of all commercial and cost-recovery harvests and following an analysis of the performance of previous tagging studies (Peltz and Miller 1990; Peltz and Geiger 1990; Geiger and Sharr 1990), an overall tagging rate of 0.00167 (1 coded wire tag per 600 fish) was chosen. A different tag code was given to each release group, a release group representing a batch of fish subjected to a certain feeding regimen (early feeding, late feeding or no feeding) and release timing. During 1994, some fish were tagged at a rate of 0.005 (1 coded wire tag per 200 fish), or three times the normal overall tagging rate. These lots were part of a Sound Ecosystem Assessment experiment to ascertain whether juvenile salmon above 60 mm in length had higher survival rates than those less than 60 mm in length.. The A.F. Koernig and W.H. Noerenberg facilities both had 2 lots of the fish tagged at the higher rate. In addition, at the W.H. Noerenberg facility, about 7,000 tagged fish meant to represent a "normal" release group were inadvertently dumped into a pen containing fish in the Sound Ecosystem Assessment predator-prey experiment. The tag code associated with these fish was voided. Fish marked with this tag were treated as a separate release group, and a subsample of fry were marked with a different code to represent the fish in the original release group.

Pink salmon fry to be tagged were randomly selected as they emerged from incubators. Fry were anesthetized in a 1 ppm solution of MS-222 prior to removal of adipose fins and application of

tags. Half-length coded wire tags were applied with a Northwest Marine Technology tag injector (model MKIV). Adipose fin-clipped and tagged fish were passed through an electronic quality control device to test for tag retention. Rejected fish were held and retested later. If rejected a second time, they were killed to minimize the number of untagged clipped fish in the release. Fry which retained tags were held overnight at the Prince William Sound Aquaculture Corporation hatcheries and for 72 hours at the Solomon Gulch facility to determine short-term mortality and tag-loss. Mortality was determined by counting the number of fish floating on the surface after the holding period. The tag loss rate was estimated by randomly selecting 200 fish and testing them with the quality control device before release into saltwater rearing pens. Tag placement was checked periodically, but not quantified.

At the Prince William Sound Aquaculture Corporation hatcheries, after the overnight holding period and prior to release, all tagged fry were introduced into saltwater pens within the larger pens holding their unmarked cohorts. This allowed determination of short-term saltwater mortalities through enumeration of floating mortalities. At the Solomon Gulch hatchery, tagged fry were transferred to the saltwater net pen holding their unmarked cohorts following the 72 hour mortality check in freshwater; no saltwater mortality estimate was made on the tagged fish. The number of fry released with tags of tag code *t*, Tr_t, was estimated for each release group by deducting both the short-term tagging and saltwater rearing mortalities (for the Prince William Sound Aquaculture Corporation facilities) from the number of fry initially tagged, and accounting for tag loss :

$$\hat{Tr}_t = (T_t - Mo_t - Msw_t)(1 - \hat{Lo}_t), \qquad (1)$$

where,

T_t	=	total number of tagged (*t*) fish
Mo_t	=	number of deaths during holding period among tagged (*t*) fish
Msw_t	=	number of deaths during saltwater rearing period among tagged (*t*) fish (Prince William Sound Aquaculture Corporation only) and,
Lo_t	=	proportion of tagged (*t*) fish which lost their tags during the holding period.

At all Prince William Sound Aquaculture Corporation facilities, unmarked fry entering the large saltwater rearing pens were enumerated with electronic fry counters, while at the Solomon Gulch hatchery, numbers of unmarked fry released were estimated from an inventory of embryos and subsequent mortality. Pink salmon fry mortalities were estimated visually immediately prior to release. These mortality estimates were applied equally to tagged and untagged fish to obtain final release estimates. With the exception of experimental release groups, fry releases were timed to coincide with peak plankton abundances near the hatcheries.

Tag Recovery

Commercial and Cost-Recovery Harvests

Recoveries were stratified by district, week, and processor. This stratification was chosen as a result of the findings of Peltz and Geiger (1990) who detected significant differences between the proportions of some tag codes among such strata. The differences indicate that processors tend to receive catches from only certain parts of a district and is believed to be the result of traditional tendering patterns.

Recoveries of pink salmon tags from commercial and cost-recovery harvests were made after each opening as the fish were pumped from tenders onto conveyor belts at land-based processors located in Cordova, Valdez, Seward, Anchorage, Whittier, Kodiak, Kenai, Uganik Bay and aboard two floating processors in PWS. Technicians sampled fish that were moving down the conveyer belt, and subjected each sampled fish to a visual and tactile examination for a missing adipose fin.

Data recorded for each tender included harvest type (i.e., commercial or cost-recovery catch), fishing district(s) from which the catch was taken, catch date, processor, and the number of fish examined. Catch data were later verified from fish tickets.

Heads of adipose-fin clipped fish were excised, identified with a uniquely numbered cinch strap and bagged. Once sampling was finished, individual heads were passed through a Northwest Marine Technology field sampling tag detector. The detector produced an audible signal upon detection of a metal tag in the head. This procedure yielded the numbers of tags in the sample.

All heads were then frozen, and together with sample data, were shipped twice weekly from each site to the Alaska Department of Fish and Game Coded Wire Tag Processing Laboratory in Juneau. Laboratory staff located and removed tags from heads, decoded extracted tags, and entered tag code and sample data into a database accessible to biologists in Cordova.

Brood Stock Harvests

Tag shedding from release to return and differential mortality between tagged and untagged fish lead to discrepancies between marking rates at release and recovery. Hatchery brood stocks were scanned for tags in order to estimate adjustment factors which could be used to account for the loss of tags from the population. Three assumptions inherent in the use of the brood stock for this purpose are: a) the brood stock consists only of fish reared at the hatchery, b) the tendency for a tagged fish to lose a tag or to die is similar for all fish marked at the same hatchery, and c) for a specific tag code, the marking rate in the commercial fishery is the same as that in the brood stock. It is believed that the first of these assumptions is violated at all facilities except the W.H. Noerenberg hatchery (Sharr et al. 1995c). Consequently, only the adjustment factor calculated from the brood stock from the W.H. Noerenberg hatchery was considered an appropriate quantity

with which to adjust for tag loss and differential mortality. Historical average W.H. Noerenberg adjustment factors were used for both inseason (1989-1994) and postseason (1989-1995) estimations.

The adjustment factor for the W.H. Noerenberg hatchery for a given year was estimated as the ratio of sampled fish in the brood stock to the expanded number of fish based on tags found in the sample :

$$\hat{a} = \frac{s}{\sum_{i}^{T} \frac{x_i}{p_i}} \qquad (2)$$

where

T	=	number of tag codes released from the W.H. Noerenberg hatchery *in 1994*,
p_i	=	tagging rate at release for the ith tag code (defined as number of tagged fish released with the ith code divided by the total number of fish in release group i),
x_i	=	number of tags of the ith code found in s and,
s	=	number of brood stock fish examined at the *W.H.* Noerenberg facility in 1995

The W.H. Noerenberg historical average adjustment factor was then used to adjust contribution estimates (Equation 3) if it could be shown that it was significantly greater than 1.0 at the 90% level. An appropriate test of the hypothesis : $Ho : a \leq 1.0$ is given in Sharr *et al.* (1995a).

While only the adjustment factor associated with the W.H. Noerenberg facility was used in contribution estimations, brood stock samples were taken during hatchery egg-take operations at all four Prince William Sound pink salmon hatcheries, and adjustment factors calculated. Technicians stationed at each hatchery examined approximately 99% of the fish by visual and tactile means for missing adipose fins. The number of fish sampled was recorded daily. When adipose-clipped fish were found, the heads were excised and shipped on a weekly basis along with sample data to the Tag Lab.

Estimation of Contributions and Survival Rates

Postseason Hatchery Contributions and Survival Rates

The contribution of release group t to the sampled common property, cost-recovery, brood stock and special harvests, and escapement, C_t , was estimated as:

$$\hat{C}_t = \sum_{i=1}^{L} x_{it} \left(\frac{N_i \hat{a}}{s_i p_t} \right) \qquad (3)$$

where

x_{it}	=	number of group t tags recovered in the ith stratum,
N_i	=	total number of fish in the ith stratum,
s_i	=	number of fish sampled from the ith stratum,
p_t	=	proportion of group t tagged,
a	=	historical adjustment factor associated with W.H. Noerenberg facility and,
L	=	number of recovery strata associated with common property, cost-recovery, brood stock, special harvests and escapement in which tag code t was found.

The contribution of release group t to unsampled strata, Cu_t, was estimated from contribution rates associated with strata which were sampled from the same district-week openings as the unsampled strata:

$$\hat{C}u_t = \sum_{i=1}^{U}\left[N_i * \left(\frac{\sum_{j=1}^{S}\hat{C}_{tj}}{\sum_{j=1}^{S}N_j}\right)\right] \qquad (4)$$

where

U	=	number of unsampled strata,
N_i	=	number of fish in ith unsampled stratum
S	=	number of strata sampled in the period in which the unsampled stratum resides,
C_{tj}	=	contribution of release coded with tag t to the sampled stratum j, and
N_j	=	number of fish in jth sampled stratum.

When a district-week opening was not sampled at all (an infrequent occurrence), the catch from that opening was treated as unsampled catch of the subsequent opening in the same district.

An estimate of the contribution of tag group t to the total Prince William Sound return for 1995 was obtained through summation of contribution estimates for sampled and unsampled strata. An estimate of the total hatchery contribution to the Prince William Sound return was calculated through summation of contributions over all release groups.

A variance approximation for $\hat{C}_t$, derived by Clark and Bernard (1987) and simplified by Geiger (1990) was used:

$$\hat{V}(\hat{C}_t) = \sum_{i=1}^{L} x_{it} * \left[\frac{N_i \hat{a}}{s_i p_t}\right]\left[\frac{N_i \hat{a}}{s_i p_t} - 1\right] \qquad (5)$$

Assuming that covariances between contributions of different release groups to a stratum could be ignored, summation of variance components over all tag codes provided an estimate of the variance of the total hatchery contribution. Inspection of the formula given by Clark and Bernard (1987) for the aforementioned covariances shows them to be negligible for large N and s, and to be consistently negative, so that when ignored, conservative estimates of variance are obtained. Variances associated with unsampled strata are believed to be small (Sharr et al,1995b).

The survival rate of the release group coded with tag t (S_t), was estimated as:

$$\hat{S}_t = \frac{\hat{C}_t + \hat{C}u_t}{R_t} \qquad (6)$$

where,

C_t	=	contribution of release group coded with tag t to sampled strata,
Cu_t	=	contribution of release group coded with tag t to unsampled strata,
R_t	=	total number of fish in release group coded with tag t released from hatchery.

Assuming the total release of fish associated with a tag code is known with negligible error, and that the cumulative variance contributions associated with the unsampled strata are small, a suitable variance estimate for S_t is given by:

$$\hat{V}(\hat{S}_t) = \frac{\sum_{i=1}^{L} x_{it} * \left[\frac{N_i \hat{a}}{s_i p_t}\right]\left[\frac{N_i \hat{a}}{s_i p_t} - 1\right]}{R_t^2} \qquad (7)$$

Inseason Hatchery Contributions

Two inseason estimates of hatchery contributions of pink salmon were generated for each opening. The first and more timely estimate was made using the method suggested by Sharr et al. (1995b). This method depended on the number of (undecoded) tags detected in heads of adipose-clipped fish by a Northwest Marine Technology tag scanner. Estimates using undecoded detected tags required that assumptions be made about adjustment (a) and expansion ($1/p_t$) factors (see Equation 3). For all inseason estimation, an adjustment factor of 1.71 was used, which is the historical average adjustment factor (1989-1994) associated with the W.H. Noerenberg facility. Fishery openings in the western and northern portions of Prince William Sound were assumed to harvest only late run hatchery returns to the Prince William Sound Aquaculture Corporation facilities. For openings in the Southwestern district, an expansion factor of 517 was used; this is a weighted average of all expansion factors associated with tags released at the A.F. Koernig (517),

W.H. Noerenberg (514) and Cannery Creek (600) hatcheries in 1994. The weighting scheme depended upon historical contributions of hatcheries to the Southwestern district. Using a similar weighting scheme for the Coghill and Northern districts, expansion factors of 534 and 582 were calculated. Openings in the Eastern district were assumed to harvest only the early run hatchery returns to Solomon Gulch, and an expansion factor of 489 was used. This number is the average of all expansion factors associated with releases from the Solomon Gulch facility in 1994. The second method, which used fully decoded data, was invoked less frequently. Fully decoded data were usually available about one week after the heads were collected, and the results were consequently not as useful to managers. Calculations of inseason contributions were consistent with those used to generate postseason results (Equation 3). Postseason estimation was a more thorough, but less timely method which used data from extracted and fully decoded tags, and which allowed use of tag-specific expansion factors and an updated W.H. Noerenberg adjustment factor.

RESULTS

Tagging

Pink salmon fry were released from the A.F. Koernig, W.H. Noerenberg, Cannery Creek, and Solomon Gulch hatcheries in 1994 (Table 1). Pink salmon were by far the most abundant salmon species cultivated and released from Prince William Sound hatcheries. Numbers of pink salmon fry released ranged from 85 million for the Cannery Creek hatchery to 162 million for the W.H. Noerenberg hatchery. Excluding experimental releases, tagging rates were in the region of 0.0017. Experimental release groups were tagged at a rate of 0.005. The numbers of codes applied were 6, 9, 17 and 16 by the Solomon Gulch, Cannery Creek, W.H. Noerenberg, and A.F. Koernig hatcheries, respectively. Approximately 7.0 and 7.7 million fry were released in the experimental groups from the A.F. Koernig and W.H. Noerenberg hatcheries, respectively.

Table 1 Pink salmon tagging data for fish released into Prince William Sound in 1994, returning in 1995.

Hatchery	No. Fish Released (millions)	No. Tag Codes	No. Fish Tagged	Range of tagging rates
Armin F. Koernig	92.08	16	178,900	0.00167-0.005[a]
W.H. Noerenberg	162.4	17	316,100	0.00165
Cannery Creek	84.6	9	141,100	0.00166-0.00170
Solomon Gulch	149.5	6	305,700	0.00169-0.00233
Totals	488.58	48	941,800	

a Including experimental release group

Tag Recoveries

Sampling Rates

Approximately 23% of the pink salmon captured in the common property and 24% of those captured in the cost-recovery harvests were sampled during 1995. These sampling rates were functions of the magnitudes of the catch, the number of samplers and the time period the fish were accessible to the samplers. The proportion of the pink salmon brood stock sampled was 99%.

Estimates of Contributions

Tags from hatchery-produced pink salmon were recovered in the common property, cost-recovery, test fishery and brood stock harvests. Hatcheries contributed 13.08 million pink salmon (76%) to the total Prince William Sound catch of 17.16 million (Table 2). The Solomon Gulch hatchery contributed the largest number (6.76 million fish:39% of total catch), while the A.F. Koernig facility contributed the smallest number(0.78 million: 5% of total catch). The common property fisheries harvested 10.8 million pink salmon, of which 7.82 and 2.98 million were estimated to be of hatchery and wild origin, respectively (Table 2). The cost recovery fisheries harvested 5.10 million pink salmon of which 4.26 and 0.84 million were estimated to be of hatchery and wild origin, respectively.

The agreement between inseason estimates based upon detected tags and postseason estimates of hatchery contributions was district-dependent. Inseason and postseason estimates of hatchery contributions to the Eastern district common property fishery agreed very closely (Figure 2). Some of the differences between the estimates were attributable to changes in the catch data over the season. The inseason estimates for the Southwestern district were significantly higher than the postseason estimates, however. The reason for the discrepancies was an unusually high survival rate of the experimental release groups that had been tagged at a rate three times that of the other release groups. Since the detected but undecoded tags cannot be differentiated into separate tagging groups, all tags were expanded equally. This led to an overestimation of contributions for tagged fish originating from the experimental release groups by a factor of about three. Inseason estimates based on decoded tags agreed closely with postseason estimates, but were not generally used in management decisions because the data from which they were generated were not available for several days after an opening had occurred. Overestimation of hatchery contributions also occurred with openings in the Coghill district, again because of high survival rates of the differentially tagged experimental release groups. In contrast, the 1994 inseason estimates for all districts compared very favorably to postseason estimates (Sharr *et al.*, 1995e). Northern district inseason estimates were not used in management decisions, because of concerns over the possibility of excessive tag shedding in fish tagged at the Cannery Creek facility

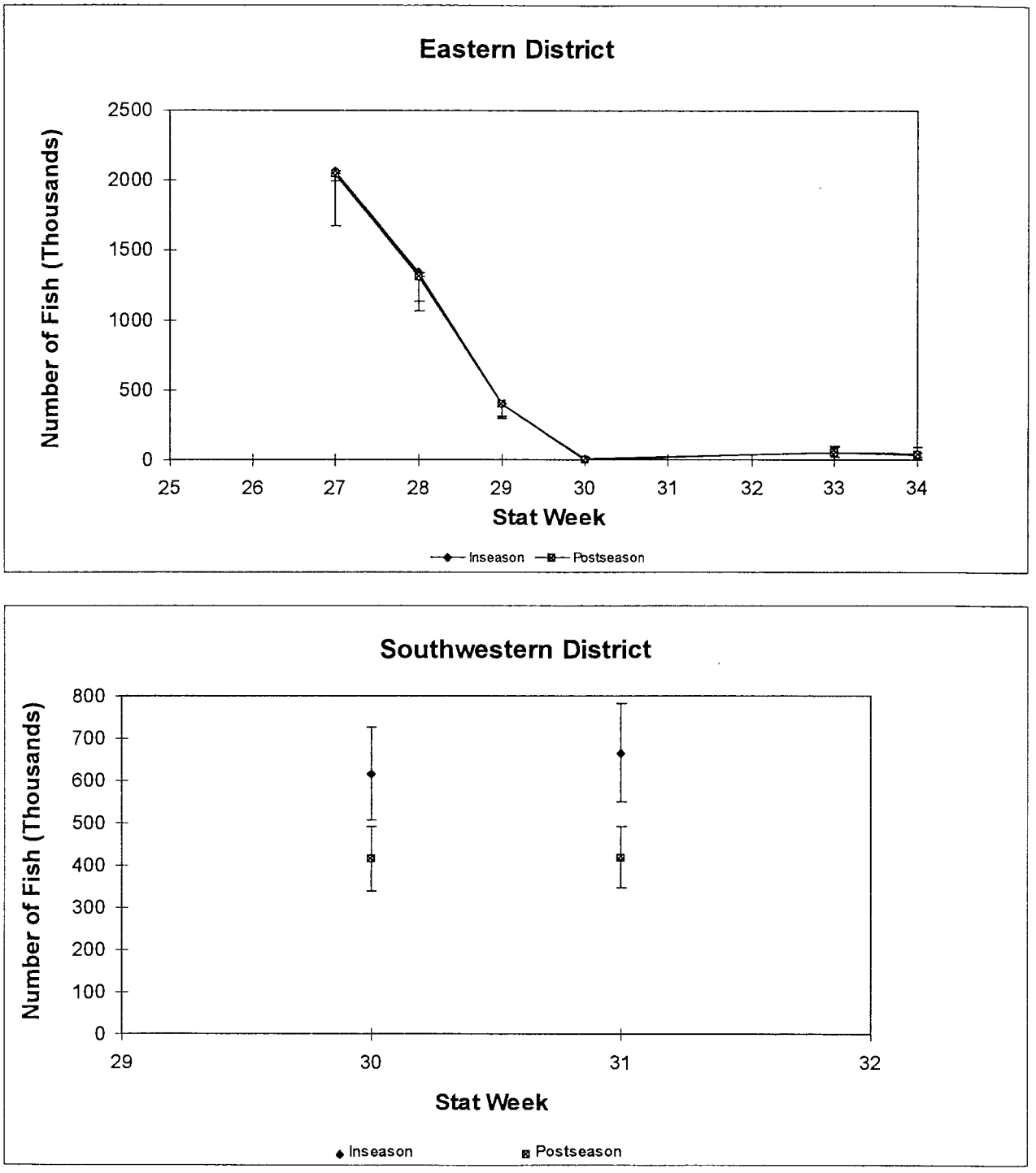

Figure 2 Inseason and postseason estimates of hatchery contributions to Eastern and Southwestern district common property fisheries in Prince William Sound in 1995.

Table 2 Postseason estimates of hatchery and wild stock contributions to the Prince William Sound catch of 1995 (millions of fish).

Contributor	Common Property	Cost Recovery	Test Fishery	Brood Stock[a]	Total Contribution	95% Bounds	Percent of Total Catch
Armin F. Koernig	0.20	0.45	0.003	0.13	0.78	0.66 - 0.90	4.6
Wally Noerenberg	1.19	0.86	0.01	0.31	2.37	2.21 - 2.53	13.8
Cannery Creek	2.62	0.41	0.02	0.12	3.17	2.94 - 3.40	18.5
Solomon Gulch	3.81	2.54	0.005	0.41	6.76	6.25 - 7.27	39.4
Hatchery Total	7.82	4.26	0.04	0.97	13.08	12.26-13.9	76.2
Wild Stocks	2.98	0.84	0.11	0.15	4.08		23.7
Grand Total	10.80	5.10	0.15	1.12	17.16		100.00

a Brood stock numbers include fish used for roe stripping (chiefly at Solomon Gulch hatchery)

Test Fishery Catches

Catches during the first weeks of the Eastern district fisheries are comprised almost exclusively of hatchery fish, and the Southwestern district test fishery is the first opportunity during the season for coded wire tag information to affect management decisions. The Alaska Department of Fish and Game has conducted the Southwestern district test fishery since 1993 in order to determine when the number and percentage of hatchery fish moving through the district is high enough to warrant opening the district to commercial fishing. Approximately 12 sampling stations are scattered throughout the district, of which 9 are used regularly. Boats assigned to a specific sampling station make three sets. All catches for a given fishing period are loaded onto one tender, and the load is sampled intensively for coded wire tagged fish upon arrival at a processing plant. The 1995 test fishery began on July 25 and ended on August 2, and was divided into 5 periods. A total of 147,895 pink salmon were caught, of which 33,825 were estimated to be hatchery fish (Appendix A.1). When the catches are stratified by period, the peak catch and peak wild stock contribution occurred during the 4th period (Appendix A.1, Figure 3). The wild stock estimate from the fourth period was biased upwards by a seiner at the Chenega Wall sampling station who made ten sets before Alaska Department of Fish and Game personnel could stop the fishing. Since Chenega Wall is a very productive fishing site, oversampling at that site strongly affected the overall catch. Chenega Wall is located in the northern part of the Southwestern District, and the large quantity of wild fish caught there reflected the high catches of wild fish caught at more southerly sampling stations earlier in the test fishery.

Common Property Catches

In the common property fishery, 10.8 million pink salmon were harvested, of which 3.81, 2.62, 1.19, 0.2 and 2.98 million were estimated to be of Solomon Gulch, Cannery Creek, W.H. Noerenberg, A.F. Koernig and wild origin, respectively (Table 2).

The Eastern district common property harvest accounted for 39.2% of the total common property harvest, due to large returns of Solomon Gulch-reared fish. The Eastern district harvest was 4.23 million fish, of which 3.78 million were estimated to originate from Solomon Gulch. The majority of the fish were harvested during the weeks of July 2 and July 9 (Statistical weeks 27 and 28; Figure 4, Appendix B2). Between July 16 and September 9, the southern portion of the district was opened to fishing as a result of high aerial survey counts. Between July 16 and September 9, 0.87 million fish were harvested, of which 43% were estimated to be wild fish.

The Northern district common property harvest was the second largest after that of the Eastern district, with 3.66 million fish being harvested (Appendix B.2). The peak weekly harvest occurred from August 13 to 19 (Stat Week 33), with 1.99 million fish harvested (Figure 5, Appendix B2). The Northern district hatchery contribution may be biased downward. In the 1995 Cannery Creek brood stock, the percentage of marked fish that did not have tags was 56%, which is considerably higher than the 37% found by Sharr et al. (1995b, Appendix A) in a multi-year study of the tag to clip ratio in the commercial fishery. Use of the W.H. Noerenberg adjustment factor of 1.77 may have underestimated the contributions from this facility.

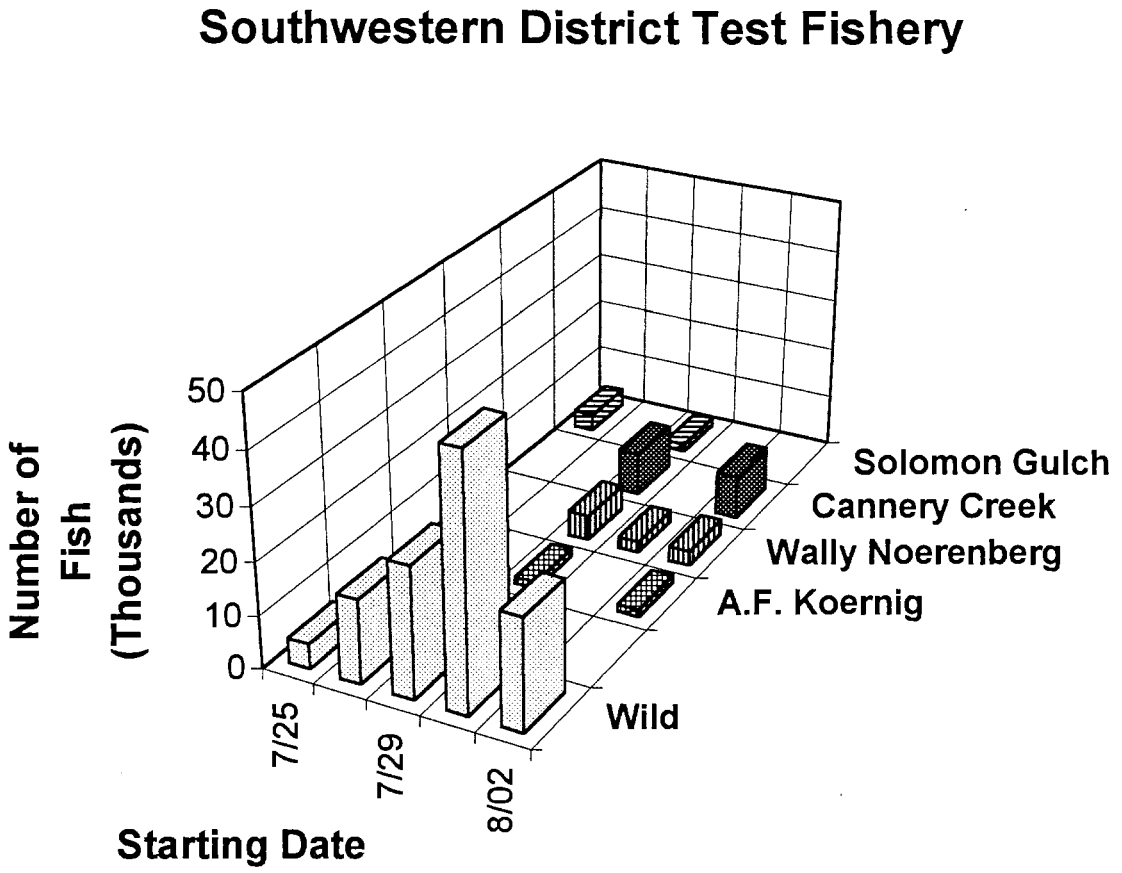

Figure 3 Hatchery and wild stock contributions to Southwestern district test fishery catches in Prince William Sound by fishing period in 1995.

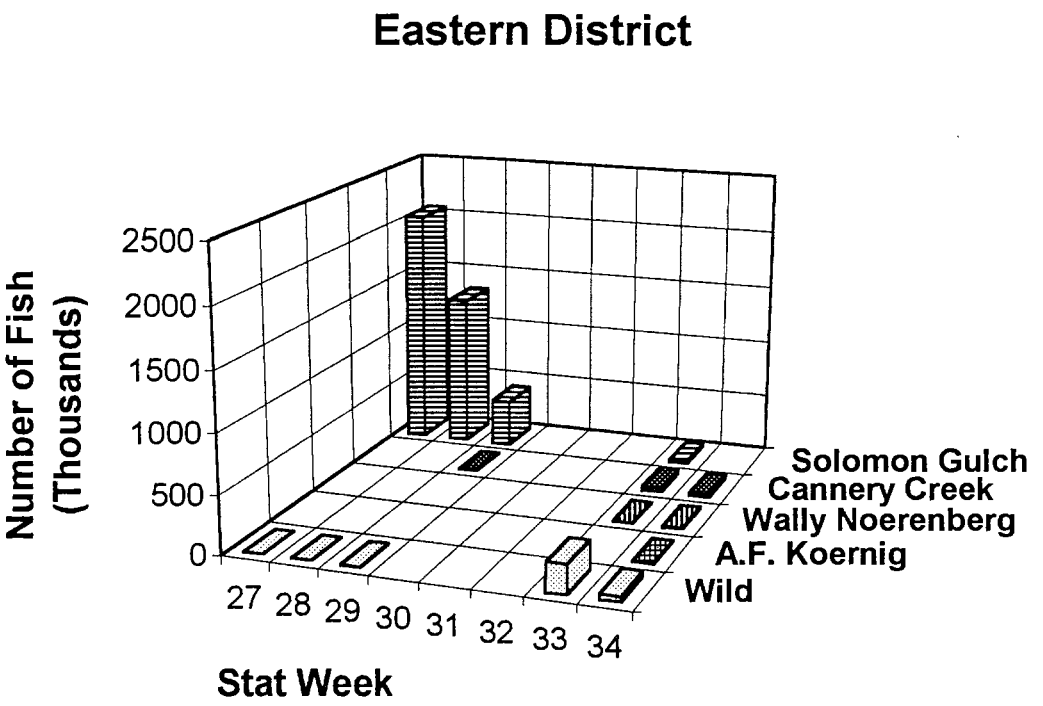

Figure 4 Hatchery and wild stock contributions to Eastern district common property fishery catches by district and week in Prince William Sound in 1995.

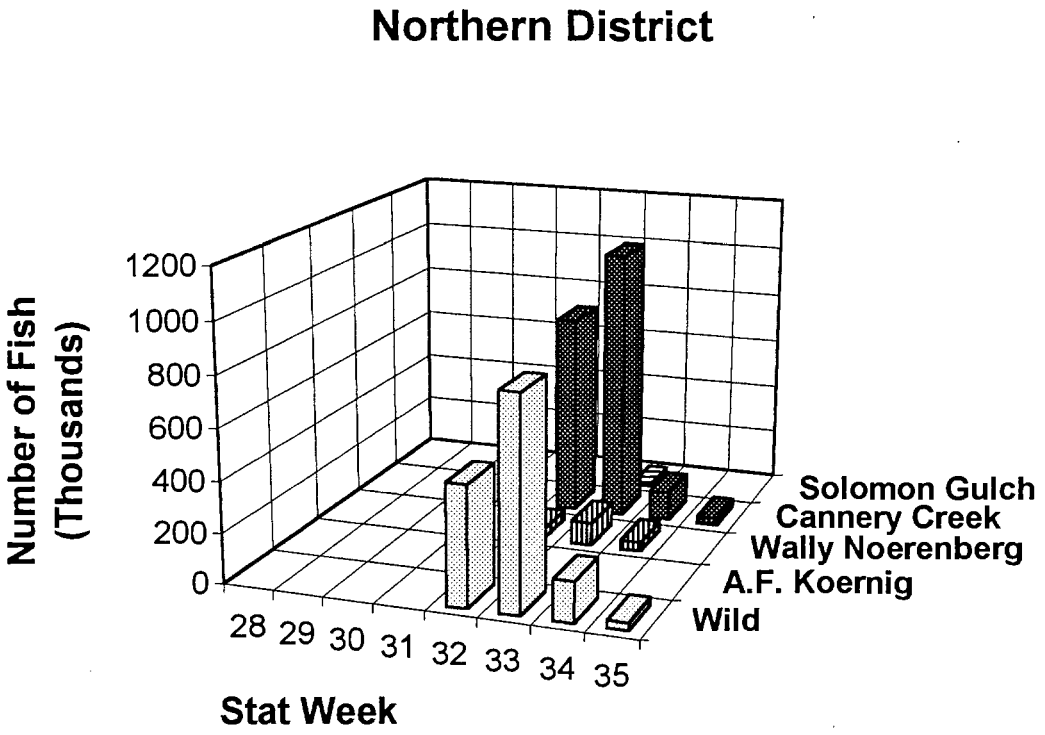

Figure 5 Hatchery and wild stock contributions to the Northern district common property fishery catches by district and week in Prince William Sound in 1995.

The 1995 Coghill district common property pink salmon harvest was 1.08 million fish (Appendix B2). The Coghill district purse seine fishery began the week of July 30 to August 5 (Stat Week 31), with 5,619 fish being caught, all of which were estimated to be of wild origin (Figure 6, Appendix B2). Peak harvest weeks were those ending on August 12 and August 19 (Stat Weeks 32 and 33), with 0.326 and 0.584 million fish being caught, respectively. Prior to July 31, the pink salmon harvested were incidental to the gillnet fishery targeting sockeye salmon. The W.H. Noerenberg hatchery was the largest contributor of fish in the Coghill district, with Cannery Creek and wild fish being the second and third largest contributors, respectively. The majority of the W.H. Noerenberg fish originated from the Sound Ecosystem Assessment project release groups.

The Eshamy district had one of the smallest common property pink salmon harvests, with 88,830 pink salmon caught. The only sampling conducted in the Eshamy district occurred during the last week of the fishery. Wild fish were the largest contributor to the common property harvest, with the W.H. Noerenberg and Cannery Creek hatcheries being the second and third largest contributors, respectively.

The Southwestern District was fished for only 2 weeks (Figure 7). It is likely that the common property fishery would have been further restricted had the true hatchery contribution not been obscured by the differential tagging of the experimental release groups. The inseason estimate based upon detected tags indicated a hatchery contribution of 82%, while the decoded tag estimate was 50%. In total, 1.71 million fish were caught in the district with wild fish being the largest contributor, and the Cannery Creek, W.H. Noerenberg and A.F. Koernig facilities being the second, third and fourth largest contributors, respectively.

Cost Recovery Catches

The total 1995 cost recovery harvest was 5.10 million fish (Table 2). Almost 50% of the harvest was taken in the Eastern district (Appendix B.3). The high percentage reflects both the comparatively high survival rates of Solomon Gulch pink salmon, and the Valdez Fisheries Development Association's policy of harvesting fish for a specific revenue goal instead of for a fixed percentage of the catch, as is required of the Prince William Sound Aquaculture Corporation. Solomon Gulch pink salmon comprised the largest portion of the total cost recovery catch (2.54 million), followed by W.H. Noernberg fish (0.86 million), wild stocks (0.84 million), A.F. Koernig fish (0.45 million), and Cannery Creek fish (0.41 million).

The 1995 cost recovery fishery for the Eastern district began during the week of June 18 (Stat Week 25), and peaked during the week of July 2 (Stat Week 27) with 1.05 million fish caught (Figure 8, Appendix B3). Tag recoveries indicated that the cost recovery harvest was exclusively comprised of Solomon Gulch hatchery pink salmon. Cost recovery was completed the week ending July 22 (Stat Week 29).

For the cost recovery harvest in the Northern District, over 60% was estimated to be of wild origin, with Cannery Creek hatchery pink salmon comprising the rest (Figure 9, Appendix B3).

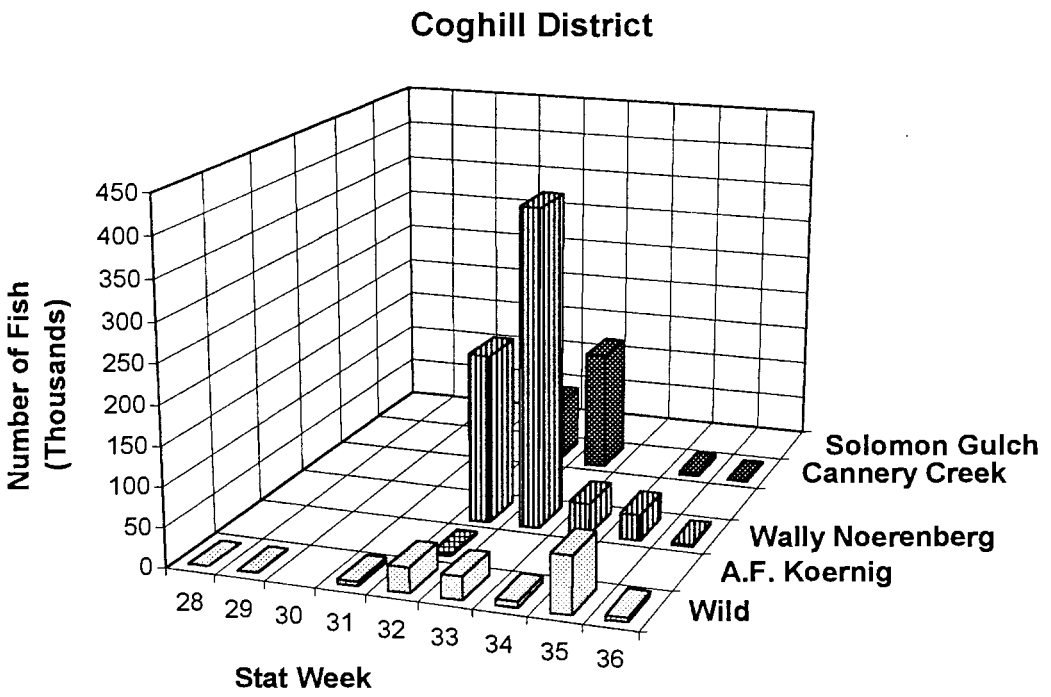

Figure 6 Hatchery and wild stock contributions to Coghill district common property fishery catches by district and week in Prince William Sound in 1995.

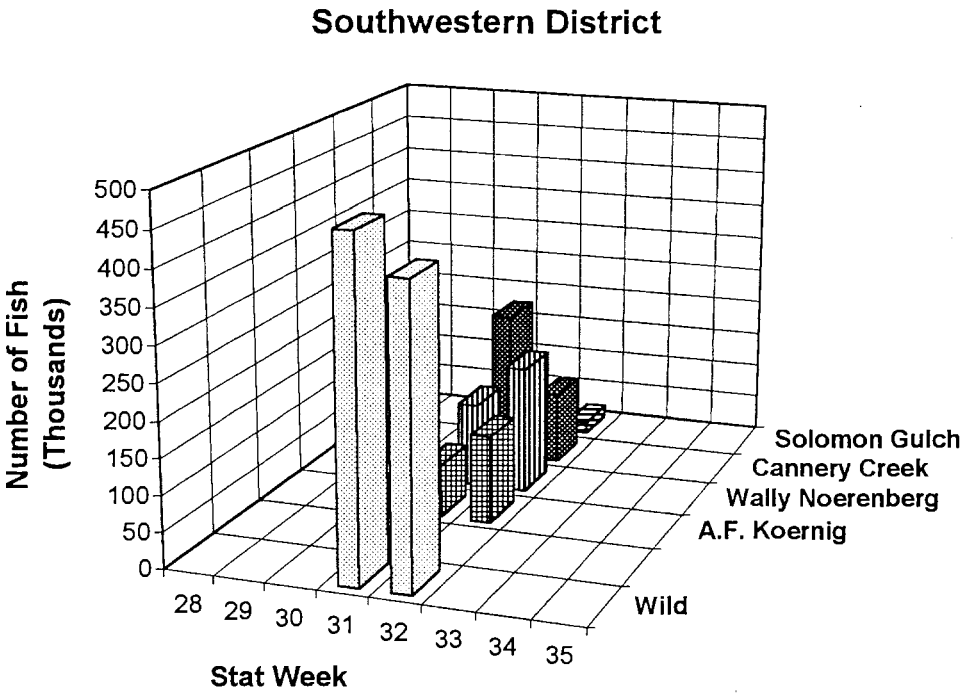

Figure 7 Hatchery and wild stock contributions to Southwestern district common property fishery catches by district and week in Prince William Sound in 1995.

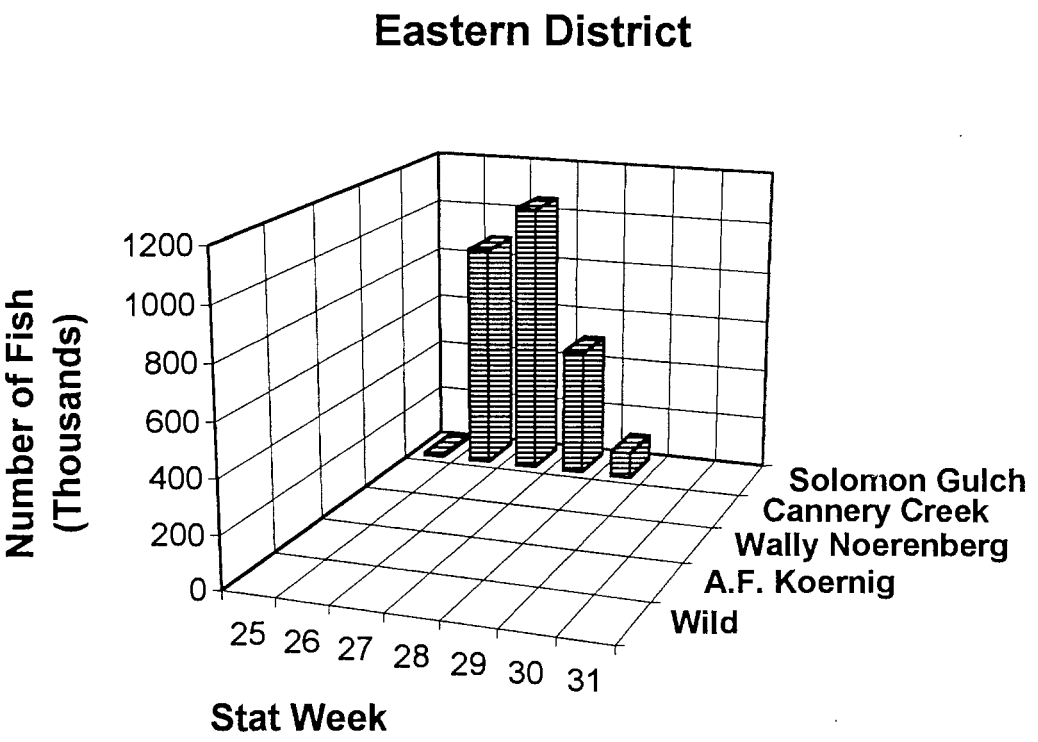

Figure 8 Hatchery and wild stock contributions to Eastern district cost recovery fishery catches by district and week in Prince William Sound in 1995.

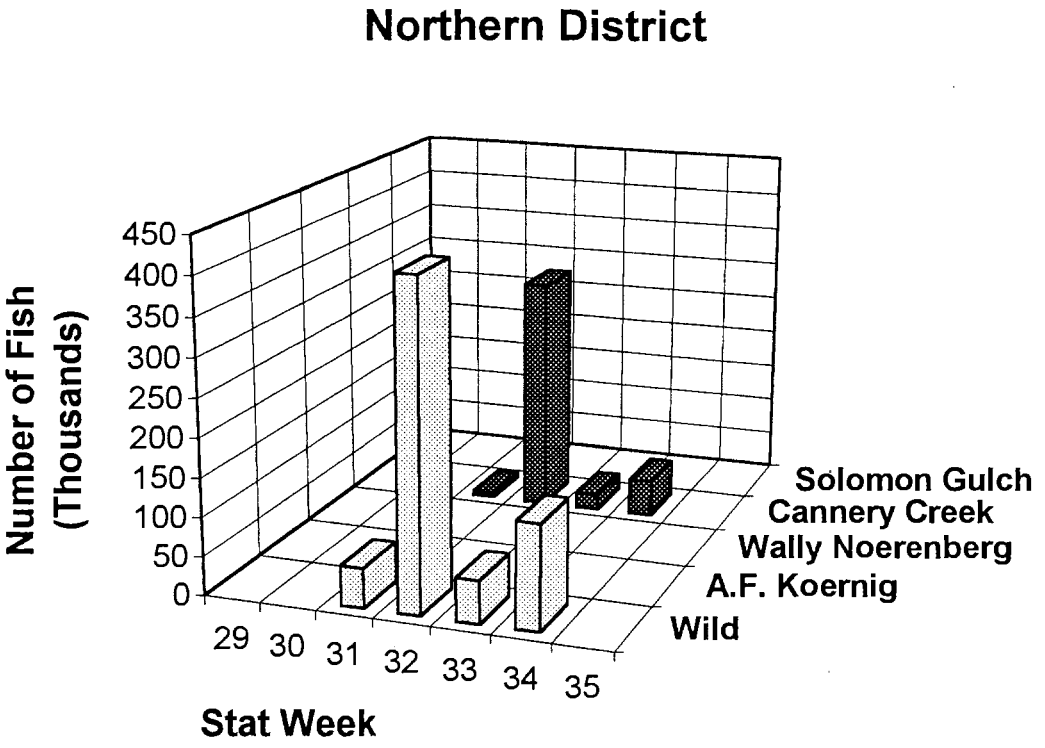

Figure 9 Hatchery and wild stock contributions to Northern district cost recovery fishery catches by district and week in Prince William Sound in 1995.

The hatchery contribution estimates are somewhat suspect, since 72% of the marked fish retrieved in sampling did not have tags, and aerial surveys in the district indicated mediocre escapements for wild stocks. Cost recovery began during the week of July 30 (Stat Week 31), and ended the week of August 20 (Stat Week 34). A total of 1.04 million fish were harvested, with a peak of 0.722 million fish harvested during the week of August 6 (Stat Week 32).

In the Coghill district, the first harvests of pink salmon occurred during the week ending July 22 (Stat Week 29) in the chum salmon cost recovery harvest (Figure 10, Appendix B3). A total of 0.93 million pink salmon were caught, of which 0.84 million were estimated to originate from the W.H. Noerenberg hatchery. Large harvests of pink salmon began during the week of August 5 (Stat Week 31), and peaked during the week ending August 19 (Stat Week 33).

A total of 0.04 million pink salmon were caught in the Eshamy district cost recovery fishery which included nearly 0.03 million believed to be of wild origin. No fish from the Eshamy district cost recovery were scanned, and the estimates of hatchery contributions were based upon samples taken from the Eshamy district common property fishery during the week ending September 2.

The Southwestern district pink salmon cost recovery harvest totaled 0.55 million fish, of which 0.45 million were estimated to have originated from the A.F. Koernig hatchery (Figure 11, Appendix B3). The second and third largest contributors were wild fish and the Cannery Creek hatchery with 0.078 and 0.014 million fish, respectively. The harvest peaked during the week ending August 19 (Stat Week 33).

Survival Rates

Survival rates (over all tag codes) of adult hatchery pink salmon were 4.52% for Solomon Gulch, 3.75% for Cannery Creek, 1.42% for W.H. Noerenberg, and 0.83% for A.F. Koernig (Table 3). Significant differences (α=0.05) in survival rates of hatchery-reared fish were detected between all hatcheries. Since evidence exists that Cannery Creek hatchery returns may be underestimated, comparisons of survival rates between Cannery Creek and other hatcheries (most especially Solomon Gulch) should be treated with caution. The overall survival rates of the W.H. Noerenberg and A.F. Koernig facilities were considerably affected by returns of fish associated with the experimental release groups (Figure 12, Appendix C). Ten out of sixteen tag codes from the A.F. Koernig and ten out of seventeen tag codes from the W.H. Noerenberg hatchery were associated with survival rates below 0.5%. The Sound Ecosystem Assessment project release groups had extraordinarily high survival rates, especially those from the W.H. Noerenberg hatchery. The estimated survival rates of these experimental release groups were 7.46% and 6.29% for the two groups released from the A.F. Koernig facility and 23.5% and 21.1% for the groups released from the W.H. Noerenberg facility. The survival rates of the non-experimental release groups released from the A.F. Koernig hatchery continue to decline (see Sharr et al., 1995c and e).

Adjustment Factors

Adjustment factors were estimated from pink salmon brood stocks and are presented in Table 4. The smallest brood stock adjustment factor was for Solomon Gulch at 1.45. Cost recovery adjustment factors for the Solomon Gulch and Cannery Creek hatcheries were 1.34 and 5.55 respectively. The brood adjustment factor for W.H. Noerenberg was 1.96, which was the second smallest of the brood adjustment factors. The W.H. Noerenberg historical (1989-1995) adjustment factor estimate of 1.77 was found to be significantly greater than 1.0, and was used for all postseason contribution estimates. Adjustment factors for 1989 through 1995 are presented in Table 5.

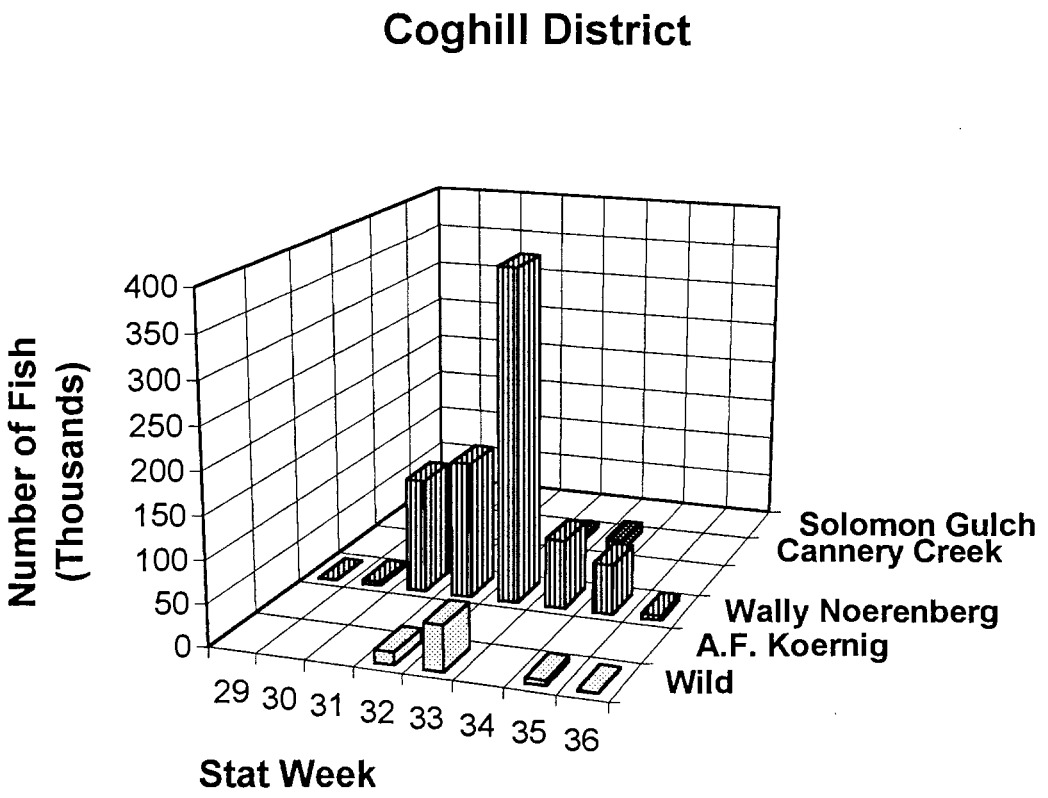

Figure 10 Hatchery and wild stock contributions to Coghill district cost recovery fishery catches by district and week in Prince William Sound in 1995.

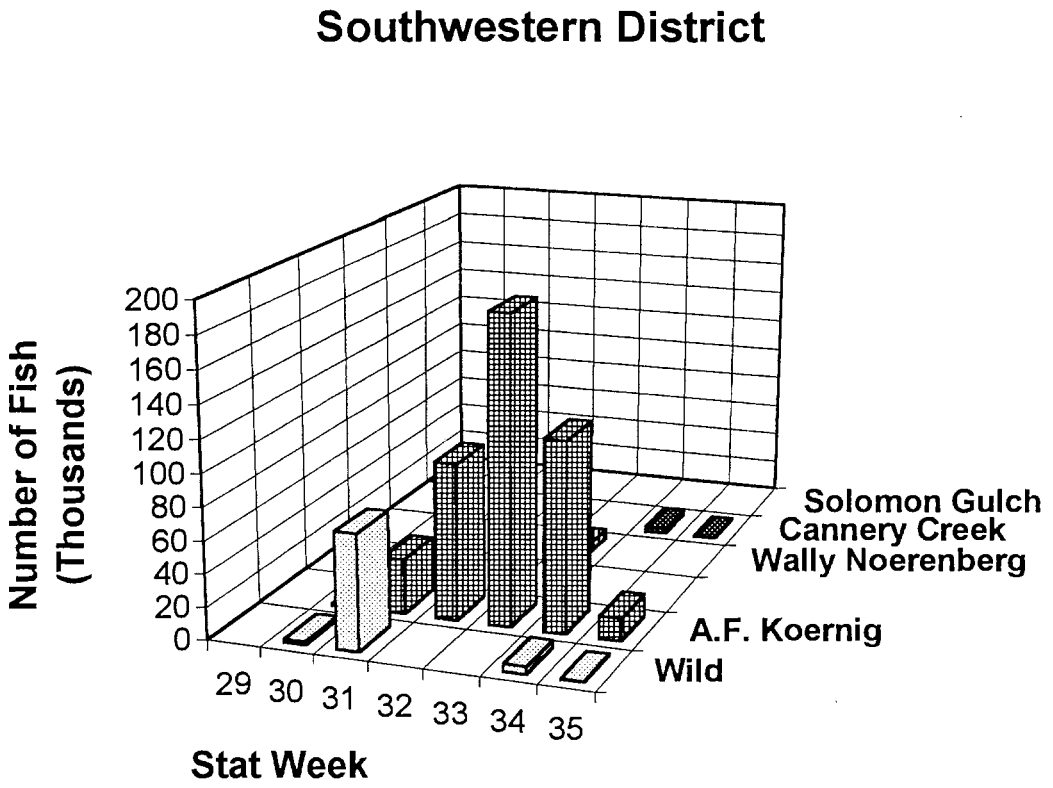

Figure 11 Hatchery and wild stock contributions to Southwestern district cost recovery fishery catches by district and week in Prince William Sound in 1995.

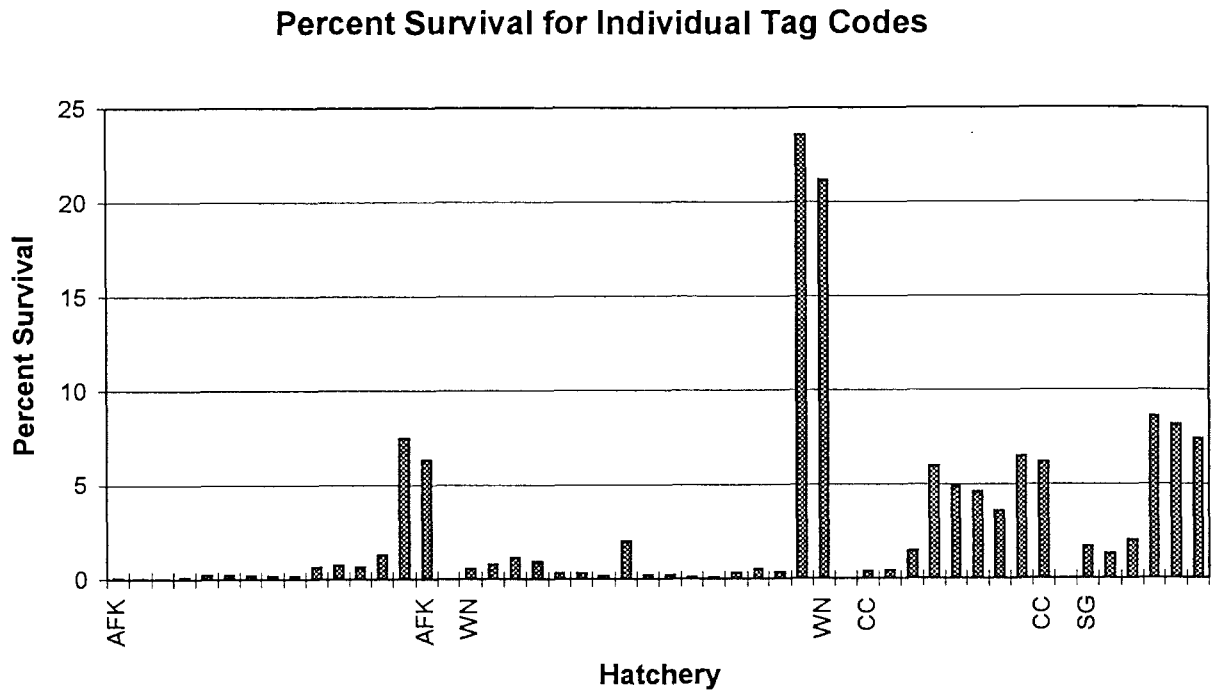

Figure 12 Percent survival rates for individual tag codes, delineated by hatchery, for tagged pink salmon returning to Prince William Sound in 1995.

Table 3 Overall survival rates by hatchery of tagged pink salmon returning to Prince William Sound in 1995.

Hatchery	Survival Rate (%)	95% Bounds
A.F. Koernig	0.83	0.71-0.96
W.H. Noerenberg	1.42	1.33-1.52
Cannery Creek	3.75	3.48-4.02
Solomon Gulch	4.52	4.00-5.04

Table 4 Adjustment factors by hatchery, estimated from the 1995 brood stock harvests.

Hatchery	Adjustment Factor		P Value for Ho: A. Factor<= 1.0
	Estimate	SE	
A.F. Koernig	2.13	0.067	0
W.H. Noerenberg	1.96	0.030	0
Cannery Creek	3.21	0.30	0
Solomon Gulch	1.45	0.053	0
Historical Average	1.77	0.127	0

Table 5 Adjustment Factors estimated from brood and cost-recovery harvests by facility for pink salmon from 1989 through 1995.

	Brood				Cost-Recovery	
Year	WHN[a]	AFK[b]	SG[c]	CC[d]	SG[c]	CC[d]
1989	1.73	1.36	1.13	2.12	1.11	1.81
1990	1.28	1.58	1.82	1.96	1.23	1.71
1991	1.82	1.45	1.94	2.28	1.55	1.97
1992	1.63	1.43	2.55	2.74	1.25	1.58
1993	1.78	2.06	3.82	2.91	2.41	2.36
1994	2.05	1.75	3.15	2.38	1.89	2.64
1995	1.96	2.13	1.45	3.21	1.34	5.55

[a] W.H. Noerenberg
[b] A.F. Koernig
[c] Solomon Gulch
[d] Cannery Creek

DISCUSSION

Contributions of Hatchery Fish to the Commercial Catch

Hatchery production of salmon in Prince William Sound has complicated management of the commercial salmon fisheries. While wild pink salmon production is overshadowed by total hatchery production, wild stocks produce a significant portion of the harvest. Wild salmon stocks were one of the three largest contributors (out of five) to the common property harvest from 1989 to 1995. During this time, a strong wild stock return in conjunction with weak hatchery returns has not taken place. For the most part, the peak returns of hatchery fish have coincided with peak returns of wild stocks in all districts, and management biologists have used spatial restriction of harvest areas to protect the weak elements with varying degrees of success.

As in the previous year, the most important task of the coded wire tag program in 1995 was to provide accurate and timely inseason estimates of hatchery contributions to fishery managers. This was attempted through the method recommended by Sharr et al. (1995c), i.e. preliminary estimation of hatchery contributions was based solely upon numbers of detected but undecoded tags. Inseason estimates of contribution rates were made available to fishery managers within 24-48 hours of the termination of the fishing period. The program was seriously compromised in 1995, however, by the extraordinary survival rates of some intensively tagged experimental release groups. Significant overestimation of hatchery contributions in the preliminary estimates for some of the openings resulted. Upon receipt of tag-specific information, the estimates were revised downwards. They were, however, of limited value to managers because of the time which had elapsed. In addition, it is believed that tagging problems at the Cannery Creek hatchery and the use of the W.H. Noerenberg adjustment factor of 1.71 may have resulted in underestimation of contributions from this facility. The agreement between preliminary and postseason estimates for the Eastern district (Figure 2) underscores, however, the utility of the coded wire tag program as a management tool when differential tagging and tag-retention problems are not factors.

No intensively tagged experimental groups were released in 1995, and thus the overestimation problems encountered in this study should not be a factor in 1996. Tagging practices at the Cannery Creek facility did not change from 1994 to 1995, and so if there was an underestimation of hatchery contributions in 1995 because of a tagging problem in 1994, there is no reason to suspect that it will not reoccur in 1996, i.e. the problem may be chronic in nature. Although tag to clip ratios can be misleading in as far as they are subject to sampler bias with regards to variable definitions of a clipped adipose fin, inspection of the ratio in Cannery Creek broodstocks from 1989 to the present (around 50-60)%) suggests that tag shedding may be problematic for pink salmon tagged at Cannery Creek. There is some anecdotal evidence to support this contention. Hatchery staff have noted that the radio will interfere with the quality control device responsible for determining whether the injected tags remain in place. When interference occurs, the quality control device randomly accepts fish without tags and rejects fish with tags. The

response of the tagging crew has sometimes been to turn off the quality control device when this occurs, which means that they are tagging without feedback on tagging success. While there is evidence of tag application problems at Cannery Creek, it is considered prudent to wait for data from the otolith-marking program to make more definitive statements regarding the matter. As mentioned, tag-clip ratios can be misleading when sampler bias exists, and the large jump in adjustment factors in 1995 in the brood harvests without a concomitant decrease in the brood stock tag-clip ratios warrants caution in use of these ratios in the formulation of conclusive statements regarding problems at Cannery Creek. Otolith data will allow us, for example, to assess the degree of straying of wild fish into the brood pond, and will indicate the extent to which it influences the adjustment factor. Absence of wild fish in the brood would be evidence in favour of the tag-shedding hypothesis.

Survival Rates of Hatchery Fish

The overall marine survival rates dropped for all hatcheries by about 50% from the previous year, but were nevertheless average for the Cannery Creek and Solomon Gulch hatcheries. If tagging problems exist at the Cannery Creek facility, the survival rates for that hatchery are being underestimated. The overall marine survival was poor for the W.N. Noerenberg and A.F. Koernig hatcheries, and would have been much poorer were it not for the experimental release groups. Roughly 63% of the return to the A.F. Koernig hatchery originated from these groups, which constituted about 7.5% of the pink salmon released, while about 74% of the pink salmon return to W.H. Noerenberg hatchery originated from experimental release group (5% of release). It is possible that predators are preying heavily on pink salmon juveniles released from these hatcheries, and also perhaps on wild pink salmon stocks on the western side of Prince William Sound.

Adjustment Factors

Adjustment factors were developed to address violations of underlying assumptions in the analysis; namely that fish do not lose tags, and that mortality rates are the same for tagged and untagged fish. Appropriate use of this concept relies on a further set of assumptions, however, such as that regarding the absence of wild fish in the brood pond from which the adjustment factor is calculated. It has been believed that the latter assumption is violated at all facilities except the W.H. Noerenberg hatchery, and a historical W.H. Noerenberg adjustment factor has been used in all inseason and postseason estimates of hatchery returns from 1993 through 1995. In light of the hypothesized tagging problems at the Cannery Creek hatchery, it is possible that the original adjustment factor calculated for that facility may not be as seriously inflated as previously thought. In the absence of data quantifying either wild stock contribution to the brood or tag loss, however, reversion to the use of a separate adjustment factor for Cannery Creek hatchery is thought premature.

The adjustment factors calculated for the Solomon Gulch cost recovery and brood were the smallest of all of the hatcheries (Table 5). This is interesting, since the large Solomon Gulch adjustment factors of 1992-1994 were instrumental in the conversion to the W.H. Noerenberg historical factors. Inspection of the standard deviation (σ) of the brood stock adjustment factors over the years at each facility shows that the variation of the adjustment factor associated with the W.H. Noerenberg facility to be the smallest (σ=0.25) and that σ associated with the A.F. Koernig, Cannery Creek and Solomon Gulch facilities to be 0.31, 0.45 and 0.96, respectively. It could be speculated that the variability for the latter two facilities is due to natural oscillations in wild populations local to the facility, with corresponding variations in the degree of immigration of wild fish into the brood pond. It is clear from the above discussion that further data are needed to answer the questions regarding the correct use of adjustment factors at all facilities.

Proper investigation of adjustment factors requires additional information, which we hope will be furnished by the otolith marking program (R95320C). In that study, all pink salmon released from Prince William Sound hatcheries in 1996 will be thermally marked, with fish from each facility receiving a different mark. Every fish lacking the otolith mark in the 1997 brood stocks will be considered wild, and an estimate of the proportion of wild fish present will be available. Comparisons between actual brood stock composition based on otolith marking and calculations of adjustment factors should allow us to evaluate the very contentious issue of the effect of wild fish in the brood on adjustment factors. In addition, otolith marking combined with coded wire tags should allow a better investigation of tag retention rates, and possibly, rates of naturally missing adipose fins in Prince William Sound pink salmon.

CONCLUSIONS

The major objective of this study was to provide fishery managers with time and location-specific data relating to the occurrence of wild stocks in the commercial fishery, and to do this in real-time with a technique based upon detected (undecoded) tags. Some of the preliminary estimates of hatchery contributions based upon detected but undecoded tags were biased upwards because of high survival rates of intensively tagged experimental groups. It is possible that management decisions would have restricted Southwestern district fishing more had the preliminary estimates been unbiased. Following discovery of the bias in the preliminary estimates, coded wire tag information was used with caution in making management decisions. In postseason analysis, reasonably precise estimates of hatchery contributions were obtained, as were estimates of hatchery survival rates. Possible tag retention problems at Cannery Creek hatchery were uncovered, which may have caused underestimation of Cannery Creek pink salmon. Further information is required to assess this problem and may be available from the thermal otolith marking program..

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Appendix A **Pink salmon hatchery and wild stock contributions to Prince William Sound test fisheries by period and week for 1995.**

Appendix A.1 Pink salmon hatchery and wild stock contributions to Prince William Sound test fisheries by district and fishing period for 1995.

Southwestern District

Date	Period	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/25 - 7/26	1							3261	10633532	3261	10633532	4742	8003	1
7/27 - 7/28	2									0		15857	15857	0
7/29 - 7/30	3	1375	946375	4825	8996407	8265	17078178	1476	2177183	15941	29198143	24786	40727	12
7/31 - 8/01	4			2095	4387100					2095	4387100	47485	49580	1
8/02	5	1390	1933053	2786	3880072	8352	34878853			12528	40691978	21200	33728	5
Subtotals		2766	2879428	9706	17263579	16617	51957031	4737	12810715	33825	84910753	114070	147895	19

Appendix B Pink salmon hatchery and wild stock contributions in test common property and cost recovery fisheries, and hatchery brood stock in Prince William Sound by district and week for 1995.

Appendix B.1 Pink salmon hatchery and wild stock contributions to Prince William Sound test fisheries by district and week during 1995.

Southwestern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/29/95	30	707	500065	4958	9515908	2127	4522549	4896	13690000	12685	28228522	27644	40329	8
8/05/95	31	1966	1485671	4545	6655512	14354	14354			20865	8155537	86701	107566	11
Grand Totals		2673	1985736	9503	16171420	16481	4536903	4896	13690000	33550	36384059	114345	147895	19

Appendix B.2 Pink salmon hatchery and wild stock contributions to Prince William Sound common property fisheries by district and week during 1995.

Eastern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/08/95	27							2048084	3.76E+10	2048084	3.76E+10	0	2048084	884
7/15/95	28							1312439	1.68E+10	1312439	1.68E+10	0	1312439	648
7/22/95	29					1228	347953	401677	2.29E+09	402905	2.29E+09	1160	404065	334
7/29/95	30									0		96105	96105	0
8/05/95	31													
8/12/95	32													
8/19/95	33			2344	3421171	35681	2.23E+08	16353	94940000	54378	3.21E+08	241176	295554	10
8/26/95	34	1091	464666	8867	1.45E+07	24960	1.05E+09			34918	1.20E+08	44161	79079	9
9/02/95	35													
9/09/95	36									0		312	312	0
Subtotals		1091	464666	11211	1.79E+07	61869	3.28E+08	3778553	5.69E+10	3852724	5.72E+10	382914	4235638	1885

Northern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/12/95	32			36318	1.57E+08	793870	3.63E+09			830188	3.78E+09	469885	1300073	194
8/19/95	33			91223	3.89E+08	1069141	5.20E+09	4204	14750000	1164568	5.60E+09	825853	1990421	229
8/26/95	34			36041	48660000	114392	3.29E+08			150433	3.78E+08	156929	307362	28
9/02/95	35					28913	21630000			28913	21630000	29349	58262	11
Subtotals		0		163582	5.95E+08	2006316	9.18E+09	4204	14750000	2174102	9.79E+09	1482016	3656118	462

Coghill District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
6/17/95	24											1	1	0
6/24/95	25											27	27	0
7/01/95	26											11	11	0
7/08/95	27											60	60	0
7/15/95	28											103	103	0
7/22/95	29											304	304	0
7/29/95	30													
8/05/95	31											5619	5619	0
8/12/95	32	1680	2349728	213997	7.69E+08	78772	1.39E+08			294449	9.1E+08	31729	326178	183
8/19/95	33			403334	2.21E+09	151969	3.13E+08			555303	2.53E+09	28730	584033	281
8/26/95	34			38691	17290000					38691	17290000	7496	46187	15
9/02/95	35 1/			32599	91520000	4253	15570000			36852	1.07E+08	70844	107696	15
9/09/95	36			2558	563684	334	95898			2892	659582	5560	8452	0
9/16/95	37											22	22	0
Subtotals		1680	2349728	691179	3.09E+09	235328	4.67E+08	0		928187	3.57E+09	150506	1078693	494

1/ Proportions from week 34 were used to allocate the catch.

Eshamy District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/08/95	27									0		271	271	0
7/15/95	28									0		1656	1656	0
7/22/95	29 2/	34	484	1292	303582	327	10713			1653	314779	2900	4553	0
8/29/95	30 2/	18	148	713	9263	180	3269			911	12680	1604	2515	0
8/05/95	31													
8/12/95	32	594	148866	22649	93340000	5736	3293728			28979	68782594	50856	79835	15
Subtotals		646	149498			6243	3307710	0		31543	97110053	57287	88830	15

2/ Proportions from week 32 were used to allocate the catch.

Southwestern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/05/95	31	73269	1.68E+08	118077	2.75E+08	212231	1.04E+09	10051	48070000	413628	1.53E+09	465052	878680	149
8/12/95	32	122602	3.56E+08	179440	4.23E+08	99770	4.59E+08	16442	95460000	418254	1.33E+09	410811	829065	188
Subtotals		195871	5.23E+08	297517	6.98E+08	312001	1.50E+09	26494	1.44E+08	831882	2.86E+09	875863	1707745	337

Montague District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/26/95	34									0		12292	12292	0
9/02/95	35									0		5947	5947	0
Subtotals		0		0		0		0		0		18239	18239	0

Southeastern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/19/95	33													
Subtotals		0		0		0		0		0		11418	11418	0
Grand Totals		199288	5.26E+08	1188143	4.49E+09	2621757	1.15E+10	3809250	5.7E+10	7818438	7.4E+10	2978243	10796681	3193

Appendix B.3 Pink salmon hatchery and wild stock contributions to Prince William Sound cost recovery fisheries by district and week during 1995.

Eastern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
6/24/95	25							8282	11440000	8282	11440000	0	8282	6
7/01/95	26							878823	4.04E+10	878823	4.04E+10	0	878823	497
7/08/95	27							1054189	4.29E+10	1054189	4.29E+10	0	1054189	416
7/15/95	28							494839	1.59E+10	494839	1.59E+10	0	494839	212
7/22/95	29							99445	6.86E+08	99445	6.86E+08	0	99445	39
Subtotals		0		0		0		2535578	9.99E+10	2535578	9.99E+10	0	2535578	1170

Northern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/05/95	31					5380	9645212			5380	9645212	51249	56629	3
8/12/95	32					305680	2.14E+09			305680	2.14E+09	417212	722892	57
8/19/95	33					20003	44440000			20003	44440000	54650	74653	9
8/26/95	34					47524	1.79E+08			47524	1.79E+08	134913	182437	12
Subtotals		0		0		378587	2.38E+09	0		378587	2.38E+09	658024	1036611	81

Coghill District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/22/95	29 1/			444	11091					444	11091	0	444	0
7/29/95	30 1/			4788	1289734					4788	1289734	0	4788	0
8/05/95	31			134385	1.02E+09					134385	1.02E+09	0	134385	21
8/12/95	32			160433	2.29E+08					160433	2.29E+08	14504	174937	15
8/19/95	33			392949	5.04E+08	5784	1631351			398733	5.06E+08	52232	450965	170
8/26/95	34			81176	1.12E+08	10611	6027524			91788	1.18E+08	0	91788	21
9/02/95	35			59036	29650000					59036	29650000	6256	65292	36
9/09/95	36 2/			5732	279477					5732	2479477	607	6339	0
Subtotals		0		838943	1.89E+09	16396	7658875	0		855339	1.9E+09	7359	928938	263

1/ Proportions from week 31 were used to allocate the catch.

2/ Proportions from week 35 were used to allocate the catch.

Eshamy District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/05/95	31									0		619	619	0
8/12/95	32									0		1946	1946	0
8/19/95	33													
8/26/95	34 3/	152	9782	5806	6133447	1470	216134			7428	6359663	13037	20465	0
9/02/95	35 3/	152	9782	5779	6077232	1464	214450			7395	6301464	12976	20371	0
Subtotals		304	19564	11585	12210679	2934	430884	0		14823	12661127	28578	43401	0

3/ Proportions from week 35 of Eshamy district common property fishery were used to allocate the catch.

Southwestern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/29/95	30	708	250042							708	250042	1841	2549	2
8/05/95	31	34075	1.38E+08							34075	1.38E+08	70918	104993	8
8/12/95	32	95739	5.83E+08			10170	25960000			105910	6.09E+08	0	105910	21
8/19/95	33	187585	1.97E+09	5644	4980080					193503	1.97E+09	0	193503	103
8/26/95	34	116543	2.01E+08			2938	8632293			119481	2.10E+08	4507	123988	90
9/02/95	35 4/	13799	2819448			348	46178			14147	2865626	534	14681	0
Subtotals		448728	2.89E+09	5644	4980080	13456	34538471	0		467824	2.93E+09	77800	545624	224
Grand Totals		449028	2.89E+09	856172	1.91E+09	411373	2.42E+09	2535578	9.99E+10	4252151	1.01E+11	838001	5090152	1738

4/ Proportions from week 34 were used to allocate the catch

Appendix B.4 Pink salmon hatchery and wild stock contributions to Prince William Sound hatchery brood stock by district and week during 1995.

Eastern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/29/95	30							38936	32720000	38936	32720000	4145	43801	47
8/05/95	31							89593	5.15E+08	89593	5.15E+08	0	89593	138
8/12/95	32							106101	7.70E+08	106101	7.70E+08	0	106101	162
8/19/95	33							63287	3.28E+08	63287	3.28E+08	0	63287	134
8/26/95	34							71543	66460000	71543	66460000	15853	87396	77
9/02/95	35							37589	1.25E+08	37589	1.25E+08	0	37589	75
9/09/95	36							551	75900	551	75900	0	551	1
9/16/95	37											16	16	0
Subtotals								407600	1.84E+09	407600	1.84E+09	20014	427614	634

Northern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/26/95	34					1008	254016			1008	254016	0	1008	1
9/02/95	35					11702	12440000			11702	12440000	4459	16161	11
9/09/95	36					49947	53030000			49947	53030000	40128	90075	47
9/16/95	37					56372	59900000			56372	59900000	50646	107018	53
9/23/95	38					4254	4520766			4254	4520766	5392	9646	4
Subtotals						123283	1.30E+08			123283	1.30E+08	100625	223908	116

Coghill District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
7/15/95	28			1						1		0	1	0
7/22/95	29			7						7		0	7	0
7/29/95	30			3						3		0	3	0
8/05/95	31			21						21		0	21	0
8/12/95	32			4						4		0	4	0
8/19/95	33													
8/26/95	34			18920						18920		0	18920	38
9/02/95	35			58645						58645		0	58645	137
9/09/95	36			102929						102929		0	102929	258
9/16/95	37			117913						117913		0	117913	282
9/23/95	38			15576						15576		0	15576	34
Subtotals		0		314019		0		0		314019		0	314019	749

Southwestern District

Week Ending	Stat Week	AFK Hatchery		WN Hatchery		CC Hatchery		SG Hatchery		Total Hatchery		Total Wild	Total Catch	Number of Tags
		Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance	Contrib.	Variance			
8/26/95	34	1819	1483994							1819	1483994	1083	2902	3
9/02/95	35	41128	23690000							41128	23690000	4965	46093	92
9/09/95	36	74185	48230000							74185	48230000	11527	85712	152
9/16/95	37	13857	9493414							13857	9493414	8793	22650	27
Subtotals		130989	82897408	0		0		0		130989	82897408	26368	157357	274
Grand Totals		130989	82897408	314019		123283	1.30E+08	407600	1.84E+09	975891	2.05E+09	147007	1122898	1773

Appendix C Percent survival by tag code of pink salmon returning to Prince William Sound in 1995.

Appendix C.1 Percent survival by tag code of pink salmon returning to Prince William Sound in 1995.

Origin	Tag Code	# Tagged	# Released	Estimated Percent Survival	Standard Error	Lower 95% Conf. Interval	Upper 95% Conf. Interval
A. F. Koernig	1301030108	13,427	6,618,697	0.049596	0.36406	0.	0.120954
	1301030109	10,541	60324,498	0.016791	0		
	1301030110	9,213	5,527,509	0.019212	0		
	1301030111	9,741	5,844,629				
	1301030113	9,179	5,507,274	0.095969	0.038343	0.20816	0.171122
	1301030114	10,208	6,125,031	0.231033	0.095736	0.043389	0.418677
	1301030115	8,570	5,142,018	0.226232	0.082136	0.065245	0.387219
	1301030201	8,243	4,946,477	0.197874	0.11882	0.	0.430762
	1301030202	10,577	6,345,996	0.16298	0.05695	0.051356	0.274603
	1301030203	10,794	6,476,718	0.146823	0.065212	0.019006	0.274640
	1301030204	11,143	6,685,569	0.650078	0.205886	0.246541	1.053616
	1301030205	10,450	6,270,226	0.747400	0.15818	0.437366	1.057433
	1301030206	11,368	6,821,127	0.644830	0.200624	0.251606	1.038054
	1301030207	10,191	6,398,894	1.303599	0.251904	0.809865	1.797333
	1301030303	17,732	3,547,896	7.461411	1.119573	5.26705	9.655774
	1301030304	17,481	3,496,392	6.291389	0.893904	4.539336	8.043441
Wally Noerenberg	1301020401	15,977	9,371,637	0.534149	0.099969	0.33821	0.730089
	1301021214	2,229	1,300,230	0.793112	0.183494	0.433464	1.152761
	1301021312	18,674	11,211,336	1.113184	0.153949	0.811441	1.414925
	1301021313	19,208	11,540,914	0.906253	0.137294	0.637156	1.175351
	1301021314	19,917	12,040,148	0.294916	0.068438	0.160777	0.429056
	1301021315	19,744	11,872,060	0.324124	0.084269	0.158955	0.489293
	1301021401	20,181	12,163,694	0.156990	0.0875	0.	0.328491
	1301021402	19,977	19,977	1.996349	0.133013	1.735642	2.257056
	1301021403	20,324	12,055,003	0.206729	0.073913	0.061859	0.351599
	1301021404	20,706	12,328,148	0.179387	0.043744	0.093648	0.265126
	1310121405	20,214	12,126,815	0.094160	0.046921	0.002193	0.186127
	1301021406	20,098	12,106,415	0.065842	0.039793	0.	0.143838
	1301021407	20,113	12,214,122	0.315546	0.078754	0.161187	0.469905
	1301021408	20,385	12,336,261	0.495401	0.10529	0.289032	0.701770
	1301021409	19,965	12,010,977	0.332658	0.069442	0.196550	0.468766
	1301030305	18,990	3,803,426	23.53498	1.343817	20.9011	26.16886
	1301030306	19,469	3,905,582	21.15258	1.247775	18.70694	23.59822

Appendix C.1 Page 2 of 2.

Origin	Tag Code	# Tagged	# Released	Estimated Percent Survival	Standard Error	Lower 95% Conf. Interval	Upper 95% Conf. Interval
Cannery Creek	1301021513	16,084	9,485,711	0.364058	0.119929	0.128997	0.599122
	1301021514	15,523	9,329,671	0.425376	0.139545	0.151867	0.698886
	1301021515	15,793	9,492,115	1.464074	0.273948	0.927134	2.001013
	1310130101	15,691	9,429,516	5.993971	0.525123	4.964729	7.023213
	1301030102	45,797	9,494,035	4.886346	0.482306	3.941026	5.831666
	1301030103	16,252	9,767,701	4.605903	0.460585	3.703154	5.508651
	1301030104	16,434	9,876,333	3.60213	0.402492	2.813245	4.391015
	1301030105	15,961	9,580,712	6.481187	0.548845	5.405451	7.556923
	1301030106	13,569	8,160,820	6.165203	0.551855	5.083567	7.24684
Solomon Gulch	1301030209	49,718	28,140,000	1.67472	0.303499	1.079862	2.269578
	1301030210	49,513	29,370,000	1.309377	0.223177	0.871948	1.746805
	1301030211	50,381	24,170,000	2.017086	0.269197	1.489458	2.544713
	1301030212	53,421	23,740,000	8.600124	1.023131	6.594788	10.60546
	1301030213	68,860	29,553,648	8.166784	0.899825	6.403126	9.930443
	1301030214	33,785	14,500,000	7.397067	0.735555	5.955378	8.838755